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WEST EUROPE REPORT  
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BIOTECHNOLOGY

HOECHST CONCENTRATES RESEARCH ON HUMAN INSULIN, INTERFERON

West Berlin DER TAGESSPIEGEL in German 9 Jun 82 p 13

[Article by Henning Engeln: "Medications from Genetic Engineering: Pharmaceutical Industry Projects Cost-Saving Production"]

[Text] Genetic engineering will soon provide the pharmaceutical industry with the possibility of producing endogenous substances with greater purity and less expensively than before. This view was expressed by a speaker for the drug firm Hoechst at a press conference at the International Convention Center.

A second industrial revolution is to be expected from progress with research into genetic engineering. Thus, the treatment of sicknesses would be made easier, manipulated cultivated plants could be expected to have improved nutritional values and increased yeilds, bacteria which devour waste, products would eliminate environmental pollutants, and raw materials, for example metals from ores, could be obtained in a new way.

The Hoechst firm has concentrated its genetic engineering research in two principal areas: The production of human insulin and interferon by manipulated bacteria. As the spokesman for the firm indicated, the pancreases of three swine are required to supply a diabetic's ten day insulin need. An increasing number of diabetics and the side effects of the swine insulin have made the production of human insulin through genetic engineering imperative. At present, insulin is produced, however, in two separate bacteria cultures and must then be chemically combined from two parts of a molecule. The researchers at Hoechst want to circumvent this disadvantage by attempting to generate the total information for human insulin in a single strain of bacteria.

Human interferon, the second substance, which occupies a central position in genetic engineering research, plays a role in the endogenous defense of virus infections and apparently also in combatting cancer. New clinical studies confirm that this substance inhibits the growth of cancer. But at a price of 100 million marks per gram of interferon an insufficient number of experiments are possible to prove without doubt the properties of this substance. Thus the reason for production through genetic engineering is obvious.

9485

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BIOTECHNOLOGY

BRIEFS

MICROBES IN MINING--Preussag, Hannover, has shown with a demonstration unit how microorganisms can be employed to obtain metallic raw materials. Ore beds, which normal mining methods cannot economically excavate, can be mined with these helpers. In the United States alone more than 200,000 tons of copper are obtained annually through microbial leaching. According to the opinion of Preussag, raw material beds can be better exploited with the aid of microorganisms in the FRG also, which accounts for 10 percent of the consumption of the world's mining products. Experiments supported by the Federal Ministry for Research and Technology should help to close the gap on worldwide developments in this area. [Text] [Duesseldorf VDI NACHRIFTEN in German 14 May 82 p 19] 9485

CSO: 3102/343

## ELECTRONICS

### SURVEY OF MICROPROCESSORS AVAILABLE IN FRANCE

Paris ELECTRONIQUE INDUSTRIELLE in French 1 May 82 pp 25-32

[Article by Pascal Levi]

[Excerpts] In keeping with what can now be called a once-a-year appointment, our magazine presents a review of what is today available (or said to be available) in France, in all categories of microprocessors.

Since our last article (May 1981), much has changed on the French market as a result of distributorships, second source technical agreements, and the "standardization" of some catalogs. This year, for instance, Thomson-CSF and Efcis (Company for the Study and Manufacture of Silicon Integrated Circuits) will be combined into a single entity, Thomson-Efcis, as a company which distributes all the integrated circuit production (generally MOS) of the group; similarly, MHS (Matra Harris Semiconductors) and Harris Semiconductors were grouped under the Harris-MHS name, following the agreement reached by the two companies, which stipulates that MHS alone will be responsible for distributing the lines of the two companies in France only.

For a better understanding of the tables, it will probably be necessary to provide some explanations about the notation used here. For instance, microprocessors have been classified into three broad categories:

microP (microprocessors), or simply CPU;  
microT (micro-slices), or processors on a slice, cascadable like the Am°2901 of AMD, for instance;  
microC (micro-computers), or CPU with RAM, ROM, I/O, and eventually display control, A/D converter, PLL, and so on, on the same chip.

The observations column lists technical comments indicating the specificity of models, or the date of availability. And finally, it is useful to remember that designations such as XMOS or HMOS are only nomenclatures belonging to various manufacturers (NS and Intel respectively, in this case) which indicate a higher performance N-channel MOS technology resulting from a fabrication process less conventional than NMOS, and proprietary to each. HCMOS is directly issued from this type of technology, and corresponds to a faster CMOS.

Microprocessor production in 1982 (in alphabetical order)

Key: (A) Word size (bits) (B) Category (C) Technology

Référence	(A) Taille des mots (bits)	(B) Catégorie			(C) Techno- logie	Observations
		μP	μT	μC		
AMCC						
AMCC 1259	4			*	CMOS	Cde d'affichage LCD et micro-programme sur deux PLA (D)

(D) LCD display control and microprogramming on two PLA

COMMODORE SEMICONDUCTOR (Procep)						
	8	*			NMOS	
MCS650X	8	*			NMOS	
MCS651X	8	*			NMOS	
MCS6508	8	*		*	NMOS	
MCS65C0X	8	*			CMOS	
MCS65C1X	8	*			CMOS	
Z8602	8	*			NMOS	(E)
Z8603	8	*			NMOS	
Z8681	8	*			NMOS	Z8 sans ROM, ni RAM

(E) Z8 without ROM nor RAM

EUROTECHNIQUE						
	4			*	NMOS	(G)
402	4			*	NMOS	ROM externe (Famille COP)
404	4			*	NMOS	
410	4			*	NMOS	Fin 1982 (H)
411	4			*	NMOS	Fin 1982 (H)
420	4			*	NMOS	
421	4			*	NMOS	
440	4			*	NMOS	
444	4			*	NMOS	Fin 1982
445	4			*	NMOS	Fin 1982
2440	4			*	NMOS	Fin 1982
8035	8			*	NMOS	
8039	8			*	NMOS	
8040	8			*	NMOS	
8049	8			*	NMOS	
8050	8			*	NMOS	
87P50	8			*	NMOS	
80CX48	8			*	CMOS	
ETC800	8	*			CMOS	Fin 1982
18032	16	*			X MOS	Fin 1982

(F) COP family

(G) External ROM

(H) End 1982

HARRIS-MHS

HM6100	12	*		CMOS	
HM8048	8			• NMOS	
HM8035	8			• NMOS	
HM8086	16	:		• NMOS	
HM8088	8	:		• NMOS	
HM8051	8			• NMOS	
HM8031	8			• NMOS	
HM80C48	8			• CMOS	
HM80C35	8			• CMOS	
HM80C86	16	*		CMOS	~ 1 <sup>er</sup> trimestre 1983 (J)

(I) During 1982

(J) Approximately first quarter of 1983

INTERSIL

IM6100	12	*		CMOS	Jeu d'instruction PDP-8 (K)
IM80C48	8			• CMOS	
IM80C35	8			• CMOS	
IM80C49	8			• CMOS	
IM80C41	8			• CMOS	
IM80C51	8			• CMOS	ROM 32 K

(K) PDP-8 instruction set

ITT Semiconducteurs

SAA 6000	4			• CMOS	Famille pour applications spéciales (L)
MAA2001	8			• CMOS	Processeur à base de 8049 pour TV (M)

(L) Special applications family

(M) 8049-based processor for TV

OKI (J-TRONIC)

MSM5850	4	*		CMOS	sans ROM pour évaluation (N)
MSM5840RS	4			• CMOS	
MSM5842RS	4			• CMOS	
MSM5845RS	4			• CMOS	
MSM58421RS	4			• CMOS	Cde de LCD (O)
MSM58422RS	4			• CMOS	Cde d'affichage fluorescent
MSM 80C48RS	8			• CMOS	(P)
MSM 80C49RS	8			• CMOS	
MSM 80C35RS	8			• CMOS	80C48 sans ROM (Q)
MSM 80C39RS	8			• CMOS	80C49 sans rom

(N) Without ROM for evaluation

(P) Fluorescent display control

(O) LCD control

(Q) sans = without

PHILIPS - FRANCE						
FAST 1 FAST 2	16 16	*		NMOS NMOS	segmenté } (R) usage interne Philips	

(R) Segmented, Phillips internal use

RTC - SIGNETICS						
2650-A 2650-A1	8 8	*		NMOS NMOS	1,25 MHz 2 MHz	
8021	8			*	NMOS	
8035	8			*	NMOS	
8048	8			*	NMOS	
8039	8			*	NMOS	
8049	8			*	NMOS	
8041	8			*	NMOS	= UPI
80C35	8			*	CMOS	
80C48	8			*	CMOS	
8405	8			*	NMOS	famille 8400 (S)
8410	8			*	NMOS	
8420	8			*	NMOS	
8440	8			*	NMOS	
8400	8			*	NMOS	version « Piggy back »
8510	8			*	CMOS	famille 8500
8520	8			*	CMOS	
8540	8			*	CMOS	
8500	8			*	CMOS	version « Piggy back »
8X300	8	*		TTL-LS	Contrôle d'E/S rapide (T)	
68000	16	*		NMOS		
68008	8	*		NMOS	sous-produit du 68000 (U)	
68010	16	*		NMOS	mémoire virtuelle (V) (W)	
68020	16	*		NMOS	Version améliorée du 68000	

(S) 8400 family

(T) Rapid I/O control

(U) 68000 sub-product

(V) Virtual memory

(W) Improved version of 68000

SIEMENS

SAB8080	8	•		NMOS	
SAB8085	8	•		NMOS	
SAB8086	16	•		NMOS	
SAB8087	16	•		HMOS	processeur arithmétique (X)
SAB8088	8	•		NMOS	
SAB8089	16	•		HMOS	processeur d'E/S (Y)
SAB8021	8			• NMOS	
SAB8022	8			• NMOS	
SAB8031	8			• NMOS	
SAB8035	8			• NMOS	
SAB8039	8			• NMOS	
SAB8041	8			• NMOS	
SAB8048	8			• NMOS	
SAB8049	8			• NMOS	
SAB8051	8			• NMOS	
SAB8741	8			• NMOS	
SAB8748	8			• NMOS	
SAB80210	8			• NMOS	E/S série + C.N/A (Z)
SAB80310	8			• NMOS	- 80210 en « Piggy-back »
SAB80212	8			• NMOS	E/S série (AA)
SAB80312	8			• NMOS	- 80212 en « piggy-back »
SAB80215	8			• NMOS	Cde de 4 afficheurs LED 7 segments (BB)
SAB80315	8			• NMOS	- 80215 en « Piggy-back »
SAB80218	8			• NMOS	
SAB80318	8			• NMOS	- 80218 en « Piggy back »
SAB2920	25			• NMOS	processeur analogique (CC)

(X) Arithmetic processor

(AA) en = in

(CC) Analog processor

(Y) I/O processor

(BB) Control for 4 7-segment LED displays

(Z) I/O series + D/A converter

SGS-ATES

M3870	8			• NMOS	Versions à 4 MHz, (DD)
M3872	8			• NMOS	existent en 6 MHz
M3875	8			• NMOS	(suffixe « A »)
M38730	8			• NMOS	4 MHz, existent en ver-
M38731	8			• NMOS	sions « A » (6 MHz) (EE)
M38732	8			• NMOS	avec E/S série dans
M38733	8			• NMOS	tous les cas
M2870	8			• NMOS	Versions « A » disponibles (FF)
M2872	8			• NMOS	
M 2875	8			• NMOS	
M28730	8			• NMOS	
M28731	8			• NMOS	idem avec E/S série
M28732	8			• NMOS	(GG)
M28733	8			• NMOS	
M38P72	8			• NMOS	Circuits de développement
M38P733	8			• NMOS	avec EPROM - existant en
					version « A » (HH)
Z8601	8			• NMOS	(famille Z8)
Z8611	8			• NMOS	
Z8602	8			• NMOS	ROM externe
Z8603	8			• NMOS	EPROM
Z8612	8			• NMOS	ROM externe (II) circuits
Z8613	8			• NMOS	EPROM développement
Z8400	8	*		• NMOS	(famille Z80)
Z8400A	8	*		• NMOS	= Z80
Z8400B	8	*		• NMOS	= Z80A
				• NMOS	= Z80B
Z8001	16	*		• NMOS	(famille Z8000)
Z8002	16	*		• NMOS	horloges 4 MHz existent
Z8003	16	*		• NMOS	en versions 6MHz (suf-
Z8004	16	*		• NMOS	fixe « A ») (JJ)

(DD) 4 MHz versions, exist in 6 MHz ("A" suffix)

(EE) 4 MHz, exist in "A" versions (6 MHz) with series I/O in all cases

(FF) "A" versions available (GG) Same with series I/O

(HH) Development circuits with EPROM - exist in version "A"

(II) Development circuits

(JJ) 4 MHz clocks exist in 6 MHz versions ("A" suffix)

SYNERTEK (ERN)

SY6500/A/B	8	*		• NMOS	(famille 6500)
SY6502	8	*		• NMOS	
SY6503	8	*		• NMOS	
SY6504	8	*		• NMOS	
SY6505	8	*		• NMOS	
SY6506	8	*		• NMOS	
SY6507	8	*		• NMOS	
SY6512	8	*		• NMOS	6502 horloge externe
SY6513	8	*		• NMOS	6503 horloge externe (KK)
SY6514	8	*		• NMOS	6504 horloge externe
SY6515	8	*		• NMOS	6505 horloge externe
Z8-01MCC	8			• NMOS	(LL)
Z8-02MPD	8			• NMOS	Circuit de développement
Z8-03MPE	8			• NMOS	Version « Piggy-back » pour
					émulation (MM)

(KK) External clock (LL) Development circuit

(MM) Piggyback version for emulation

THOMSON-EFCIS

SFC9-2901B	4	*	*	Schottky	
EF6800	8	*		NMOS	existe en 1, 1,5 et 2 MHz (NN)
EF6801	8			NMOS	
EF6801C1	8			NMOS	pour évaluation (OO)
EF6802	8	*		NMOS	
EF6803	8			NMOS	= 6801 sans ROM
EF6805P2	8			NMOS	
EF6805P2C1	8			NMOS	pour évaluation
EF6805R2	8			NMOS	
EF6805U2	8			NMOS	
EF68705P3	8			NMOS	
EF6808	8	*		NMOS	= 6802 sans RAM
EF6809	8	*		NMOS	
EF6809E	8	*		NMOS	horloge externe (PP)
EF68000	16	*		NMOS	

(NN) Exists in 1, 1.5, and 2 MHz

(OO) For evaluation

(PP) External clock

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CSO: 3102/320

## ELECTRONICS

ERRATUM: This article is republished from JPRS 81145, 28 June 1982, No 108, of this series, pp 1-3 to correct certain translation terms.

### MICROELECTRONICS PLAN: WIN MARKET, TECHNOLOGY INDEPENDENCE

Paris L'USINE NOUVELLE in French 18 Mar 82 p 55

[Article by Daniel Lacotte: "The Two Gambles of the Second Components Plan"]

[Text] The administration has just announced important measures to promote the French integrated circuits industry. Without changing the structure of the Components Plan launched in 1978, the government has announced the basic outlines of the action which it intends to take between now and 1986: on the one hand, winning back the French market; on the other, attaining true independence with respect to integrated circuit design.

On the first point, the government has not yet reached a decision as to the aid to be granted to manufacturers in order for their production to cover the French market in 1986. On the second point, the minister of industry estimates that Fr 3.4 billion will have to be invested in research and development over a 5-year period. A budget of Fr 480 million is planned for 1982 as of this writing. In any event, the administration has set the rules of the game: one-third of the investments is to be made by the manufacturers.

#### Two Centers for Classic Circuits, Three for MOS

The French components industry will thus retain the industrial structure established by the 1978-1982 Five-Year Plan, namely: two centers for classic circuits--Radioteknique-Compelec (a Phillips affiliate) for bipolar circuits and Thomson for linear circuits, but principally three centers for MOS [metal-oxide semiconductor] circuits, which represent 50 percent of the world market.

With respect to MOS circuits (strategic components for the future), the authorities decided in 1978 to build French production on American technology. Thus, Matra is associated with Harris, and Saint-Gobain with National Semiconductor (in a common affiliate, Eurotechnique). Finally, the third MOS center is EFCIS, whose stockholders are Thomson and the AEC. Each firm has a plant (Nantes for Matra-Harris; Rousset, near Marseille, for Eurotechnique; and Grenoble for EFCIS) that started production at the beginning of last year.

The DIELI [Directorate of the Electronics Industries and Data Processing], entrusted with the electronics and computer industries in the Ministry of

Industry, confirms that "the alliances with our American partners will be maintained," and it estimates that present production capacities and plans for developing the three plants between now and 1986 will represent Fr 2.3 billion in turnover in 5 years. At this time, the French integrated circuits market is estimated at Fr 4.5 billion. The conclusion of the Ministry of Industry: In order to win over this French market, the three other plants must produce more in order to make up the difference--i.e., Fr 2.2 billion. Now it is known that in electronics, "in order to get one franc of turnover, one franc has to be invested."

Consequently, in order for French production in 1986 to be able to cover the domestic market, the manufacturers are going to have to invest an additional Fr 2.2 billion--a large sum for which the administration and the manufacturers, which have just passed into the public sector, will both assume responsibility. For the immediate future, nothing has yet been determined as to the distribution of aid to the three groups.

#### Stemming the American and Japanese Monopoly

There is still the problem of research. In the 1978-1982 plan, public credits were increased to Fr 600 million. This was not enough to attain adequate production volume and at the same time launch constructive research in future technologies. The government is contributing part of the answer, since it will encourage manufacturers to invest one-third of the Fr 3.4 billion necessary for France to have true technological independence in 1986. And the state would thus be ready to pay the remaining two-thirds. "It's a big bill, but independence comes at such a price," they say at DIELI where it is ardently hoped Matra-Harris, Thomson (EFCIS) and Eurotechnique (Saint-Gobain) will "play ball."

Up to now, over the 1978-1982 period Matra-Harris has invested Fr 200 million, Eurotechnique Fr 420 million, and EFCIS Fr 670 million (including Fr 223 million of public aid), for a total of Fr 1.3 billion. The three groups will have to work in double quicktime in the coming 5 years. And this is precisely the gamble of this second Components Plan: Will each of the three partners have the necessary industrial determination to stem the American and Japanese monopoly in the sector?

#### An Intermediate Solution for Eurotechnique

The launching of this second plan brings up again the problem of Eurotechnique. Will it try to merge the Saint-Gobain affiliate and EFCIS? At the Ministry of Research and Technology, this eventuality is considered a "folly." It is felt that the three centers originally established should instead be retained. But there are two ways of restraining them. For Eurotechnique, it is a question of knowing whether it will remain within Saint-Gobain's domain or if it will be detached from it. The administration is moving toward a median solution: Eurotechnique would continue to belong to the Saint-Gobain group but would no longer be controlled by it. The group's reaction: "It is out of the question; we want to control all the operations or none at all!"

At the start of this new Components Plan, it is no exaggeration to state that the 1978-1982 plan made it possible for the three French plants to prove mass production was possible, even if the 1981 results remain modest (production capacity was Fr 1.1-1.5 billion, while real production did not exceed Fr 500 million). Success will be conditioned by rigorous planning of public aid and the objectives to be fulfilled for each of the centers. It will also depend on the groups, and on the willingness of the men heading them to take up the bet.

9380

CSO: 3102/217

ELECTRONICS

BRIEFS

SPECIAL MICROELECTRONICS PROGRAM--The 3-year special program for the application of microelectronics initiated by Federal Minister of Research Andreas von Buelow in January and endowed with \$300 million in grants has been received with great enthusiasm. As Buelow announced in Bonn, 1,000 projects to be subsidized have been applied for in the meantime. The purpose of this program is the broad promotion of the development of new products involving the use of microelectronics in order to create internationally competitive jobs. According to the announcement, the 1,000th application comes from a company located in Lower Saxony that wishes to develop an electronic system for time detection, person identification and bookkeeping. It is to be utilized in the private and industrial sectors. As Buelow stated further, more than half of all applications filed so far are product innovations in the fields of measurement and control, particularly in mechanical engineering, but also in the areas of energy efficiency and environmental protection. Ten percent of the projects pertain to applications of microelectronics in the car industry and consumer goods. The program showed a very good response by small and medium-sized companies: more than two-thirds of all applicants employ fewer than 200 employees. The participation of large corporations was below 10 percent. [Text] [Essen ELEKTRO-ANZEIGER in German No 7, 1982 pp 5-6] 9544

CSO: 3102/318

## STEAM GASIFICATION OF COAL USING NUCLEAR PROCESS HEAT

Munich ATOMKERNENERGIE-KERNTHERMIE in German No 4, 1982 pages 225-245

[Excerpts]

### Abstract <sup>1</sup>

#### **Coal gasification by steam using process heat from high-temperature nuclear reactors**

This paper outlines the coal gasification process using a high-temperature nuclear reactor as a source of the process heat needed. Compared to conventional gasification processes coal is saved by 30-40%, coal-specific emissions are reduced and better economics of gas production are achieved. The introductory chapter deals with motives, aims and tasks of the development, followed by an explanation of the status of investigations, whereby especially the results of a semi-technical pilot plant operated by Bergbau-Forschung are given. Furthermore, construction details of a full-scale commercial gasifier are discussed, including the development of suitable alloys for the heat exchanger. Moreover problems of safety, licensing and economics of future plants have been investigated.

### Motives, Objectives and Problems of Development

### Objects and Boundary Conditions

Methods for producing gas from coal have been known and applied from the beginning of the industrial era. In the coking process coal is heated for example with exclusion of air, in which only part of the coal is converted into gas and the main product obtained is coke. In the gasification of coal, the latter is allowed to react with a gaseous partner and at temperatures above 700 degrees C with suitable reaction management a total conversion is achieved, so that only the mineral components remain as ashes. One of the most important gasification means is steam, which is converted in a heat consuming reaction with the carbon of the coal, while

<sup>1</sup> The work was carried out by virtue of the collaboration contract between: Bergbau-Forschung GmbH [Mining Research], GHT Gesellschaft für Hochtemperaturreaktor-Technik mbH [Association for High Temperature Reactor Technology], Hochtemperatur-Reaktorbau GmbH [High Temperature Reactor Building], Kernforschungsanlage Jülich GmbH [Jülich Nuclear Research Plant] and Rheinische Braunkohlenwerke AG [Rhine Braunkohl Works] on the development of the procedure for the conversion of solid fossil raw materials using nuclear process heat with the support of the Federal Ministry of Research and Technology and the District of North Rhine-Westphalia.

a gas arises which is rich in hydrogen and carbon monoxide and can be used and converted in many ways. The process is known as autothermal when by adding oxygen the required amount of heat for the endothermal reaction is generated internally in the gasifier. If the required heat is produced externally and supplied by heat exchange to the gasifier, we refer to an allothermal method. Further details on the principle and the technical application of the coal gasification may be found in the relevant literature (compare for example B.H. Juntgen, K.H. van Heek: Coal Gasification Principles and Technical Applications, Thieme Pocket Books, Volume 84, 1981). To evaluate the object of the project of steam gasification using nuclear process heat we must start from the fact that in all the previously used gasification processes the coal had a double function. It is used on one hand as raw material for the desired product, the gas or the secondary products to be produced by synthesis, and simultaneously as a source of energy for the gasification plant. In the practical procedure followed so far this led to the need of consuming 40 to 50 percent of the coal used, to generate the heat needed to implement the reaction, to generate and overheat the steam as well as to cover the other energy needs, for example in the form of electricity, so that only 50 to 60 percent of the coal is converted into gas. The objective of the project is to cover the total energy needs of the gasification plant with nuclear process heat which is obtained from a high temperature nuclear reactor. Through the procedure represented in a very simplified form in Figure 1 it is possible to obtain that 40 percent or possibly even a greater percentage of coal is saved as compared with the conventional gasification methods, the coal specific emissions, referred to the amount of gas produced are reduced considerably and finally as shown by thorough calculations, the economy is effectively improved.

The following boundary conditions of such a development may be indicated:

- The high temperature reactor provides its heat in the form of hot helium at a temperature of 950 degrees C.
- The heat coupling in a gas generator takes place from outside, allothermal gas generator.
- The system pressure is 40 bars.

#### Concept Features and Crucial Points of the Development

Figure 2 shows the selected gasification process which differs from the conventional method mainly by the type of gas generator.

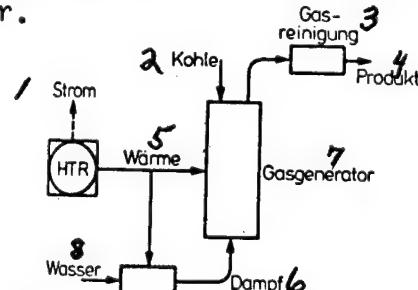


Figure 1: Schematic representation of the steam gasification of coal using heat from high temperature nuclear reactors.

Key:

1. current	3. gas purification	5. heat	7. gas generator
2. coal	4. product	6. steam	8. water

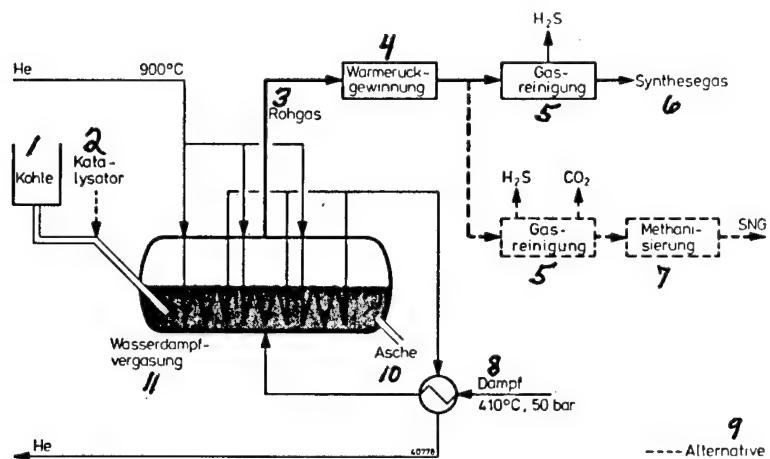


Figure 2: Concept of a gas generator with grooved fluidized bed and gasification plant.

Key:

1. coal	5. gas purification	9. alternative
2. catalyst	6. synthetic gas	10. ashes
3. crude gas	7. methanization	11. steam gasification
4. heat recovery	8. steam	

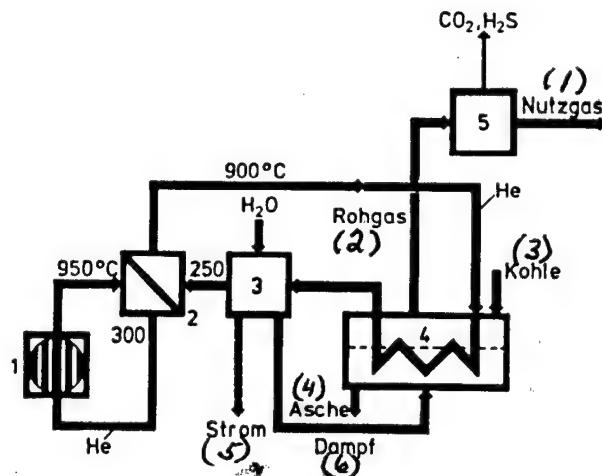


Figure 3: Association of high temperature nuclear reactor and steam gasification.

Key:

1. useful gas	3. coal	5. current
2. crude gas	4. ash	6. steam

Its most important characteristics may be characterized and discussed as follows:

The gasification means chosen was steam. The main reaction of gasification of coal with steam is the heterogeneous water gas reaction in which carbon is converted with the steam into CO and H<sub>2</sub>. This reaction consumes heat, the nuclear reactor heat can therefore be combined directly in the chemical process. Another advantage of this

gasification means is its "aggressivity". The speed of the water gas reaction does not decrease even with very high burn-up, so that basically it is possible to achieve total conversion of coal into gas. Finally the main products, hydrogen and carbon monoxide can be used in many ways so that the steam gasification of coal represents a basic process for the generation of energy carriers chemical raw materials and reduction gases.

An important feature of the gasification reactor type is the accomplishment of the reaction in a fluidized bed. On the basis of the favorable heat transfer wall to a fluidized bed it is possible to achieve only in this way sufficiently high heat transfer factors from the hot helium to the coal steam mixture to be gasified. They are of the order of about  $500 \text{ W/m}^2$  and thus allow for the first time the execution of gasification on technically satisfactory scales. The passage through solid layers lead only to a heat transfer coefficient which is smaller than a factor of about 10. Concepts based on this principle which had been pursued a long time ago as substitute solutions, have meanwhile been abandoned.

For the heat transfer a tubular heat exchanger for which the name of "Immersion" dipping in the coal steam fluidized bed was chosen. It guarantees a high surface density of the heat exchanging areas in the fluidized bed. Suitable high temperature material are basically known and available for its construction but the latter must be optimized.

The organization of the fluidized bed is in the form of an elongated groove. With such a shape it is possible to achieve a high conversion for high periods of stay needed for hard coal. This effect is based on the fact that in the fluidized bed groove remixing can be suppressed to a great extent.

The requirement for the batching of caking hard coal is derived from the fact that the open burning coal available in future for gasification in Germany has strong caking properties. The jet feed used to this end is known from the carbonization process under normal pressure; but this principle must be modified for the conditions of gasification under pressure.

Finally it was arranged to use catalysts in the gasification process. It is thus possible to increase considerably the conversion rate. Because of the chosen concept of a groove it is possible to achieve this with small additions of catalysts, since the active substance is enriched with the burn-up of the carbon in the passage through the groove.

To sum up it may be said that large fluidized bed reactors, for example for coal gasification in the Winkler method can be implemented and applied on a large scale, but the concepts described here needed for the application of nuclear process heat requires in many points a really new development. Figure 3 shows the type of gas generator and the means of its coupling with the nuclear reactor. From the nuclear reactor the heat is discharged first through the primary helium group, which transfers its heat content through an intermediate exchanger through a secondary helium loop. The helium of this loop passes through the above-mentioned immersion heater heat exchanger. There the heat is used for the implementation of the endothermal gasification reaction and, at lower temperature levels, in a steam power plant for generating steam. The latter is used at present as a gasification means and to generate electricity.

The manifold development problems were studied jointly in the project Nuclear Process Heat (PNP) by the partners indicated in footnote 1. In this connection the nuclear reactor companies have the task of assuring by design and experiments the development of the nuclear reactor with the cooling gas intermediate loop including the heat neutralizing components and the steam power plant. The Rhine Brown Coal Works is assigned to the hydrating gasification and the mining research company is developing the steam gasification of coal with the above-mentioned crucial elements.

### Steps for the Project Goal

The degree of novelty and the manifold nature of the problems to be solved make it possible to achieve only in stages the objective of the project, specifically the operation of test devices in laboratory and on the semi-technical scale for the experimental determination of the basic design data, the construction of a pilot plant and the demonstration of the procedure in a prototype plant before the industrial application in commercial plants. Figure 4 shows the stages for achieving the goals of the project through the implementation of gasification experiments in laboratory and on a semi-technical scale through the establishment of models and computer programs as well as by design work and development of materials.

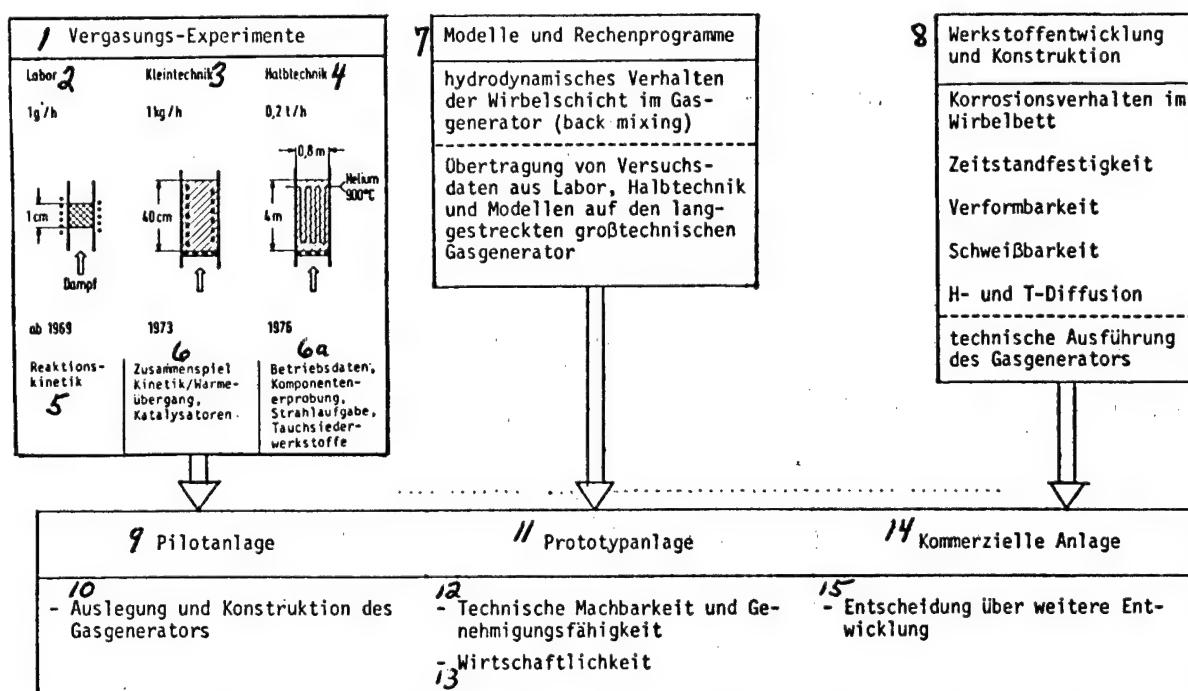


Figure 4: Steps for achieving the project goals. Key: 1. gasification experiments; 2. laboratory; 3. small scale technique; 4. semi-technical scale; 5. reaction kinetics; 6. interaction between kinetics and heat transfer, catalysts; 6a. operating data, component testing, jet feed, immersion heater materials; 7. models and computer programs, hydrodynamic behavior of the fluidized bed in the gas generator (back mixing), transfer of experimental data from laboratory, semi-technical scale and models to the long range large scale gas generator; 8. material development and construction corrosion behavior in fluidized bed resistant in time, deformability, weldability, H and T diffusion, technical structure of the gas generator; 9. pilot plant; 10. layout and construction of the gas generator; 11. prototype plant; 12. technical feasibility and possibility of approval; 13. economy; 14. commercial units; 15. decision for further development.

All these results now give rise to planning work, studies and estimates of the subsequent stage. The next stage planned is a pilot plant which could start operating in 1986. It would have a throughput of several tons of coal per hour. The reactor heat simulated here by heating with electricity or gas. Toward the end of the eighties it would be possible to decide on building the prototype plant, in which for the first time a nuclear reactor would be operated together with the gasification plant. The individual elements of planning and studies as far as concerns the mining research company the layout and construction of the gas generator, the feasibility studies, the fitness for approval and economy of the total plants. The results obtained are important principles for deciding on the further development.

### State of Studies

#### Semi-Technical Experimental Plant of the Mining Research Company.

The basic idea in the organization of the semi-technical plant was to operate in it a gasification reactor which represents a section of the large generator. For the heat exchanger it means that it has the same geometry as a section of the industrial gas generator. Figure 5 shows the immersion heater heat exchanger used in the semi-technical plant. It consists of Incoloy 800 tubes with the provided dimensions of 38 mm by 6 mm. The basic area is 800 mm by 900 mm and the height of the immersion heater dipping in the fluidized bed is 4 m. With regard to the latter it has already been stated that even the fluidized bed height to be used in the semi-technical scale of up to 4 m is oriented according to the corresponding height in the large scale technical gas generator.

But the very important consequence of this fact which must be constantly kept in mind is that for the planned gasification capacity of about 200 kg coal per hour the equipment can be designed only as a standing container and not as a groove. This means that the gasification in the standing fluidized bed reactor cannot be carried out with total back mixing which means in its turn that the high degrees of gasification can only be achieved with disproportionately high times of stay which could not be compared with the large scale variant of the fluidized bed groove.

Further features of the plant are supply of heat through an electrically heated medium loop, the operation of all gas loops and gas generator at a pressure of 40 bars as well as the jet feed for carbon batching.

### Further Procedure

#### Continuation of the Works

The implementation of the project goal, the demonstration of the steam gasification of coal using nuclear process heat must be continued in three crucial points. The purpose of the experimental studies on the laboratory scale as well as the manifold structural process technology and other theoretical studies is to establish further basic data, on which it is possible to set up the next development stages. The gasification developments on the laboratory scale and in the small scale gasification plant should be devoted predominantly to the application of catalysts. For their optimum application it is necessary to have thorough knowledge, for example on the interaction of the catalysts with the mineral substance, and thus determine measures

against inactivation of the catalysts and once again conditions for the optimum application. The plants for the study of corrosion and behavior in time of materials in process gas atmosphere and to measure the permeation of hydrogen and titium through the immersion heater material will be operated further. For a future approval process one must assure the environmental safety of the plant through load data; the latter are obtained mainly by controlled experiments on the existing test plants.

The gas generator itself represents a totally new design for which solutions must be established in detail. The latter was accomplished in the past in collaboration with the Mannesmann Company, jointly with the PNP project partners, moreover the concept studies on safety, approval fitness and environmental safety of process heat plants for coal gasification must be continued.

In the semi-technical plant the purpose is to obtain more thorough results and further developments in the next few years. The experimental program provides for the moment for permanent tests on the application of caking open burning coals by means of jet feed. This will be followed by performance experiments. After this period of tests the optimized experimental data will be available for the design of the gas generator for the gasification of caking open burning coal. On the basis of the experiments on the laboratory scale then longer experiments will follow for the application of catalysts. In this connection it will be possible to study under conditions close to the operating ones in the semi-technical plant the use of catalysts, the increase of performance obtained, but also the possible adverse effects on the plant, for instance from corrosion. Finally it is provided to test the recovery of tube gas to save steam.

The purpose of the pilot plant is to carry out experiments on a larger scale, while the testing of the long range gas generator and the determination of the spectrum of the period of retention of the solid substance to optimize the throughput and degree of gasification represent the core of the investigations. This plant will further be used for functional tests of components, permanent tests for collecting operating experience and finally testing how far the results obtained on the smallest scale can be transferred to large plants.

## 8.2 Prospects of Development

In conclusion we may once again give the reasons why according to the opinion of the PNP partners and many of the parties interested in energy policy and the concerned public consider it worthwhile to develop the steam gasification of coal using heat from high temperature nuclear reactors and consider the further steps as promising:

1. For the pilot plant because of the now more than 10 years development studies all the necessary planning documents are available. Moreover the technical and economical feasibility of the prototype plans have been insured by the work of the Mining Research Company and the project partners.
2. As compared with other gasification processes the following advantages may be indicated:
  - almost total conversion of coal (95 percent),
  - 80 to 90 percent more gas per ton of gasified coal,

- lower gas costs,
- less coal specific emissions, especially the possibility of reducing for the first time the emissions of carbon dioxide.

3. The application potential and possibilities of saving coal are very high, as may be discussed in the following examples:

If in the heating market for example 41 million tons of heating oil (EL) are replaced by SNG this could be achieved in 15 to 20 WKV plants with a gasification of 60 million tons (SKE hard coal units). Moreover electricity is generated corresponding to a coal equivalent of 18 million tons of hard coal units.

If 37 million tons of fuel are produced for traffic gasification of coal in WKV plants with subsequent Fischer-Tropsch synthesis, 17 to 22 WKV plants are required to this end with a use of coal of 69 million ton hard coal units. The saving of coal as compared with hydration is in this case 43 million ton hard coal units; moreover electricity is produced corresponding to an amount of coal of 21 million tons hard coal units.

The level reached by the present research and development as well as the important advantages for the economy justify the subsequent continuation of the research and development works.

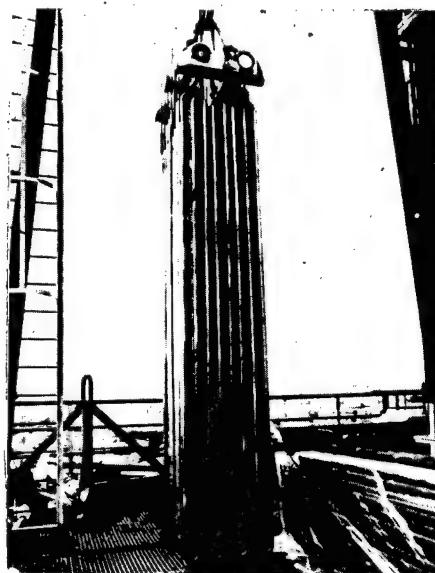


Figure 5: Immersion heater heat exchanger in the semi-technical plant of coal gasification.

COMMENTS ON BELGIAN UNDERGROUND COAL GASIFICATION PROJECT

Paris L'USINE NOUVELLE in French supplement to 13 May 82 issue pp 10-11

[Article by Claude Christophe: "Underground Coal Gasification: the Belgians Improve the Method:]

[Text] The gasification of very deep lying deposits, the production of a better performing gas which, in addition, could be transformed into a raw material for the chemical industry. Three "pluses" for the Belgian method.

Thulin in Belgium (province of Hainaut) is a small village located not far from the Belgo-French border. In the cold of a morning last February, a few personalities were brought together to witness a world premiere: the firing of a very deep lying (850 meters) coal deposit. An experiment which, thanks to an original process developed jointly by Belgo-German technicians and researchers, will make it possible to extract a gas of medium calorific power which may be transformed later on into either methanol or methane.

To gasify coal is certainly not a new idea. Mendeleyev and Siemens were already thinking about it in the 19th century. Shortly before the Second World War, the first experiments were attempted, primarily in the USSR (Angren and Yuzhno-Abinskaya). But it is not the very deep lying deposits (beyond 500 meters) that people are primarily interested in. Furthermore, the low yield of the tests have turned researchers more toward the gasification of extracted coal\* (yield of gasification: underground 60 percent, extracted coal 97 to 83 percent). Up to now, the best example is undoubtedly the SASSOL [South African Oil Supply Company] plant, in South Africa, which on the average produces 2 million tons of hydrocarbons per year from 13 million tons of extracted coal.

"But," explains Pierre Ledent, director of the Belgo-German in situ gasification experiment, "the production of a fluid fuel cannot be based on extracted coal precisely because of its limited availability and its prohibitive cost price. As for imported coal, aside from rather high prices, it entrails the risk of becoming dependent on the producers of synthetic fuel from Australia, Siberia, Wyoming or elsewhere, after having been ruled by the oil producers from Africa or the Near East."

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\*See L'USINE NOUVELLE, weekly edition No 23 of 4 Jun 1981, page 75.

The new Belgo-German process makes it possible to gasify very deep lying coal deposits (1,000 to 2,000 meters). Even though no systematic prospecting has been undertaken as yet, these deposits are estimated at approximately 80,000 tons (minable reserves) for the EEC. However, if this underground gasification process could be applied to seams located at 2,000 to 5,000 meters, this figure could be multiplied by 10.

But its originality, when compared to the other methods (multiple-faces and chambers and pillars), in addition to the fact that it makes it possible to go below 1,000 meters, lies, on the one hand, in the fact that it puts the underground gas source under high pressure so as to increase the rate of progress of the gasification face and at the same time to improve the power produced, the yield and the calorific power of the gas, and, on the other hand, in the choice of the gasifying agents--oxygen and carbon dioxide--which would make it possible, through "shift reaction," to obtain a chemical synthesis gas rich in hydrogen which, through subsequent processing, could be transformed either into methane--it would be redistributed in the public networks, or it would progressively replace natural gas--or into methanol or other substances--it would then become a feedstock for the chemical industry.

"While the Thulin experiment," specifies Pierre Ledent, "is an essential step in the development process of the underground gasification of very deep seams, it does not however foreshadow the methods of industrial exploitation." As a matter of fact, the exploitation method used at Thulin is a petroleum type method in which drilling takes place from the surface with the deflected bore hole technique. It has certainly proved itself with the development of deep sea oil exploitation. But, in the case of coal a much more sophisticated machine would be required, a kind of "smart mole" controlled from the surface, and which could stay within the thickness of a seam of coal and be directed, at will, to produce a tunnel according to a pre-established plan.

Unfortunately, such a machine is not yet available on the market. Consequently, an industrial level exploitation will require the use of a "mixed" method, in which bore holes connecting the underground gas source to the surface would only be used to inject gasifying agents and for the evacuation of the gas. The surveying of the deposit and the preparation of the mining site would be handled through a network of galleries on a virgin site, dug out by conventional mining techniques.

The fact remains nevertheless that the process appears to be probably profitable, specifically when compared to the gasification technique based on extracted coal. While it is true that the cost price of 1 megawatt hour of generated gas includes a larger portion of fixed costs (cost of preparing the underground gas source), the item "coal" is reduced to nothing and the only consumption item listed within the cost price of gas is the consumption of the electricity necessary to produce the oxygen used as a gasifying agent. Thus, 1 megawatt hour produced this way could be 10 to 40 percent cheaper!

#### Belgian Brains, but German Exploitation

"You should also take into account," adds Pierre Ledent, "the extraordinary activating effect which the mass production of synthesis gas could have on

the European economy as a whole, by improving the balance of payments of the countries of the Community\* and by stimulating the development of all the industries that could participate in the production chain created by this new form of energy: from the production of oxygen upstream from the reactors, to the production of methane, methanol, plastic materials and synthetic gasoline downstream.

Table: Various Methods of Gasification

	Belgo-German Method		
	Multiple Faces	Thulin Experiment	Future
Description of method of exploitation	Drilling networks, 20 to 30 meters away from each other, with connections for great depths and un-exploited areas between the feet of 2 bore holes, through the retro-combustion technique (so-called petroleum method)	Transposition of multiple-faces technique at very high pressure, under high pressure, toward long tunnels (so-called petroleum method)	Preparation of large size gas sources through mining work based on a network of galleries located below the deposit being exploited and gas removal through a small number of bore holes (100x-) (so-called mixed method)
Countries	USSR USA	Belgium	FRG
Depth	± 100 to 300 meters	860 to 960 meters	1,000 to 2,000 meters
Gasifying agent	Compressed air	1st stage: air + steam; 2d stage: oxygen + steam	oxygen + carbon dioxide
Power per face	2 to 20 megawatts thermal hours	15 to 25 megawatts thermal hours	200 to 250 megawatts thermal hours (per gas source)
Injection pressure	3 to 4 bars	45 bars	45 bars
Advantages and Disadvantages	-lack of impermeability of underground gas source; -interference with aquifers; -low thermal power	-better impermeability of gas source; -increased yield and productivity	-possibility of developing industrial size units

\*Europe spends about 774 billion francs per year for its energy supply.

However, if the brain is Belgian, the exploitation will be German. As a matter of fact, a single coal conversion unit, based on the methods used in organic chemistry, cannot be profitable below a production level of 3,000 megawatts thermal (5 million tons of extracted coal), and the FRG is the only country in Europe, if not in the world, to have the required set of techniques at its disposal (production of oxygen; the washing of the gas; conversion of carbon dioxide; final purification; mining techniques at very great depths, etcetera). "I would have liked to turn underground gasification into a European affair," concludes Pierre Ledent, "but if some interest can be detected on the part of the English and the Dutch, the French seem to have a clear desire to go it alone. They seem more interested in gasification from extracted coal."

8463

CSO: 3102/296

## ENERGY

### SWISS PLAN 5 MW SOLAR POWER PLANT IN ALPS

Zurich CHEMISCHE RUNDSCHAU in German 19 May 82 p 3

[Article by RWD]

[Text] In the mid-1980's a solar thermal electrical power plant (abbreviated Sotel) with a 5 MW maximum output is planned for the high Swiss Alps. To accomplish this a consortium was established in 1980 which in addition to the Federal Institute for Reactor Research and the Emmen Federal Airplane Plant includes 10 prominent Swiss industrial firms. In the past 2 years basic questions about size, technology, planning and construction time as well as cost have been clarified.

#### 100 m High Tower, 25,000 m<sup>2</sup> Reflector

At 5 MW the capacity has been set higher than for solar power plants already operational or planned for southern Europe. The Sotel technology is in accordance with the principle of the solar tower unit: A field of 500 heliostats (automatically revolving reflectors) each with 50 m<sup>2</sup> reflecting surface concentrates the solar radiation on a steam generator which is located at the top of an approximately 100 m high tower; the steam drives a turbogenerator to produce current. Approximately five times the total reflecting surface is required in land area, thus about 125,000 m<sup>2</sup> wasteland.

Working out the construction-stage project should take 14 months. In the process the location will also be determined. Possible sites are in the cantons of Ticino and the Grisons as well as in the Bernese Alps. If construction begins in 1984 and if permit hurdles are taken in rapid stride, Sotel could begin test operations in 1986.

#### Economical Only by the Year 2000

The central question for this project with long-range goals is an economic one. At 1980 prices the 5 MW Sotel unit would cost 50 million francs, thus each installed kilowatt would cost 10,000 francs. If plant costs are estimated at 1 million francs per year, then each kilowatt hour in Switzerland, where an annual 1,750 operating hours are calculated, would

amount approximately to 1 franc; at 3,200 hours in sunny countries the costs for current would be cut approximately in half.

Starting from this still extremely uneconomical base, the consortium is also considering that: First of all, specific investment costs would have to be considerably reduced through mass production (to 6,000 francs for each installed kilowatt for 5 MW units). Secondly, the increasing capacity of the power plant would result in a diminution of production costs for current (for a 50 MW unit they would be only one-third as high as for a 5 MW unit). Thirdly, it is not improbable that the real prices of the conventional energy sources will increase 2 percent annually. The conclusion from all of this: Price-wise, thermally produced solar current should be competitive around the year 2000.

#### Basic Unit for Export

By that date at the latest there should be an active demand for solar thermal power plants, not so much in the Alpine countries as in the sunny countries. The consortium is, then, primarily hoping for an export market. If Switzerland could maintain its current 4 percent share of the world market, then that would mean annual export sales on the order of 300 million francs at the turn of the century. A prerequisite for success with exports is, to be sure, a basic unit at home, and that is Sotel.

Currently the consortium is looking for the 2.3 million francs required for the actual designing. The members of the consortium would like to begin the design work in the current year so that the technical know-how gained through Swiss participation in the solar tower power plant of the IEA in Almeria, Spain, does not become obsolete.

9485  
CSO: 3102/341

ENERGY

BRIEFS

PILOT WIND-POWER PLANT--The Hague, July 7--The government today revealed a plan to set up between ten and 20 windmills for electricity generation as a pilot project. A decision on the type of mills and their siting will be taken before the end of the year, so that the windmill farm can go on stream in 1985, it said in a report. The government will pay half of the 35-million-guilder investment and the Cooperating Electricity Production Companies (SPP) will chip in the other half. The mills will have a capacity of between 0.3 and 0.5 megawatt each, the report said. Economics Minister Jan Terlouw told a press conference after today's cabinet meeting a decision on storage of surplus power production was not necessary as long as windmill generation remained below 2,000 megawatts, a volume not expected to be reached before the mid-1990's. [Text] [The Hague ANP NEWS BULLETIN in English 8 Jul 82 p 3]

CSO: 3102/384

## INDUSTRIAL TECHNOLOGY

### MESSER GRIESHEIM PERFECTS AUTOMATIC ORBITAL WELDING

Paris INDUSTRIES & TECHNIQUES in French 1 Jun 82 pp 95-96

[Article by A. Colombier: "Entirely Automatic Orbital Welding Thanks To a Transistorized Power Supply With a 20 kHz Pulsation"]

[Text] Because of its great adjustment flexibility and its "purity," the tungsten inert gas welding process is used in advanced technologies--aeronautical, nuclear or space. Far from remaining constant during the welding operation proper, the intensity is generally pulsated. Its value ranges from the melting point to a value usually much lower. This succession of hot and cold periods is repeated several times per second and prevents the metal from running. This proves very useful to counteract the effect of gravity when welding on the ceiling or along a descending vertical. Until now, with thyristor and transducer power supplies, the pulsation frequency was low and the arc obtained inadequate for many applications.

The German welding giant, Messer Griesheim, has perfected a "MULTITIG" transistorized power supply for automatic tungsten inert gas welding, which uses direct current of up to 320 A. This power supply operates with a basic frequency of 20 kHz and is therefore suitable for aluminum welding. The device guarantees a constant useful current  $\pm$  1 percent above 100 A, and  $\pm$  1 A below 100 A, in spite of fluctuations which can reach  $\pm$  10 percent at the start. The arc intensity is continuous, or follows a descending slope with an inclination adjustable from 0 to 90°. The pulsation frequency can be continuously selected from 0.1 to 1,000 Hz, the pulses increasing from 4 kA/s to 2 MA/s. The range of the frequency band is such that the pulse edges can be adjusted from the softest to the strongest values.

The accurate control of the heat applied ensures problem-free welding during critical passes from the bottom into position. With a microprocessor-controlled computer and an orbital welding head, this supply source can be used for the automatic and precision welding of tubing, for instance in the construction of nuclear reactors. The orbital head is then mounted on a carriage which revolves around the tube at a constant speed. That speed, as well as the vertical and lateral displacements of the torch, the unwinding of the wire, the back-and-forth motions of the torch and the changes in its angle of attack are controlled by a motor with a high degree of precision. The sequences are reproducible.

## Nine 45-Step Programs

For work in position, the computer can provide a programmation of the power supply in sections corresponding to the different positions. When there are no more than six steps, the time, the basic current, the pulse current, the rectilinear slope (time required for current transfer), the length of application and the power of the current used to preheat the sheet metal, as well as the timing of the pre- and post-currents for the protective gas are programmed. An intensity recorder is used to document the cycle. Established welding programs can be recorded on a punched tape and reused whenever required. The system has been field-proven on several nuclear construction sites, for the orbital welding of very thick CrNi steel tubing, under difficult working conditions (little room to install the tubing). Its profitability as well as the excellent quality and the reproducibility of the welding in position have been demonstrated.

Another computer, Model G 04, makes it possible to enter, display, memorize and read 9 programs of up to 45 steps. For each step, up to 20 parameters can be selected. The succession of the sequences is controlled as a function of the distance travelled or the time elapsed. The programs are entered on a keyboard; the parameters of the current cycle, of the previous and of the following cycle are displayed on the screen. The programs are recorded on cassettes and printed for control and documentation purposes.

Jointly with this computer, a head control (MOK 43) can pilot two orbital heads, or welding guns or tongs, as required. For one of the orbital heads (OK 2), the control involves the carriage motor drives, the unwinding of the wire, the vertical displacement of the torch, the oscillation, the angular and lateral displacements, and the oscillation amplitude and the wire angle. This head, provided with a belt-driven carriage, is more specially intended for the precision welding of thick tubes, of diameters larger than 200 mm, in close quarters.

Up to 28 parameters measured at different locations can be simultaneously displayed in various colors on the display screen. The measurement values are shown as rows of percentages. The tolerances on the parameters can be programmed in increments of 1 percent. For subsequent processing, documentation and process control, analog output signals and non-potential contacts are available for each of the 28 channels.

The assembly can be connected to a welding simulator. This is a microprocessor-controlled resistor which can vary rapidly and is used to test power supplies. The device simulates an arc in a form standardized for all arc-welding processes, up to 800 A of direct current and 2,000 A of short-circuit current. It is especially useful to study drop transfer, trigger short-circuits, and arc-length variations. It records the dynamic and static operating characteristics. It will be used to develop new power supplies and for the quality control of series production, in short or continuous tests.

The investment required to purchase a MULTITIG system ranges from 150,000 to 200,000 francs. This system is not yet sold in France, but some 30 units are already in service throughout the world.

## INDUSTRIAL TECHNOLOGY

### FRG MACHINE-TOOL RESEARCH CENTER 'BEST IN WORLD'

Paris INDUSTRIES & TECHNIQUES in French 1 Jun 82 pp 77-85

[Article by Andre Larane: "Aachen, a Mecca for Machine-Tools"]

[Text] A flexible cell, a milling lathe, a power laser... A hundred spectacular, strange, or... confidential projects in progress. A new machine moves in or out every other week. A research center which is probably the best of its kind in the world.

The Germans are no longer the kings of the machine-tool. Very well. They have been outstripped by the United States and Japan. All the same, their Aachen laboratory remains the best in the world. In one particular field, that of mechanical engineering, it is ahead of the American MIT and leaves the French centers far behind. For these reasons, a report on their Aachen Technical Institute and its Machine-Tools and Industrial Administration Laboratory (WZL) was in order. We discovered astounding inventions. For instance, a combined milling machine/lathe which, unfortunately, we were not yet allowed to photograph. This combination of two machines as widely different as a fish and a rabbit will probably be offered to manufacturers in 1984. It is the most spectacular of all research projects, but several others offer greater technical interest. Approximately every other week, a machine moves in or out. Simultaneously, a power laser and a high-speed milling machine are installed, a water-spray cutting machine is moved and a press is disassembled. "Mechanical engineering progresses very rapidly. In order to remain dynamic, we cannot spend more than two or three years on a given project," Prof Wilfried Koenig states. "If a team were to exceed that length of time, we might forget it in its corner."

Some 100 projects are in progress. Some are dealing with fundamental research. They are financed by the Technical Institute (20 percent of the total) and by public funds from the Rhineland-Westphalia land or from federal ministries (69 percent). Others are carried out under agreements with industrialists and machine-tools manufacturers. Some others are the result of three-way agreements with companies and ministries. The Laboratory's 500 employees, a handful of whom only are involved in teaching, are working full time on these projects. But the premises also house job training facilities for workers. Of the 150 engineers, many are Aachen graduates preparing their doctorate. As one of them tells us, business hours are devoted to the projects. The

theses come second. This is why the workshop is still busy in the evening. But this overload of work proves profitable. Upon its graduation, a German doctor-engineer will receive over 10 job offers.

#### Lack of Fluency in English or German Too Often Causes Our Technicians to Ignore German Research

No wonder then if many students of the Paris Advanced School for Industrial Arts are in Aachen to work on their graduation report or to prepare a doctoral thesis. The principal of their school is quite glad to provide them with this additional training. But the exchanges of students are limited by the language barrier. Thus, a future graduate of the Advanced School for Industrial Arts admits that he had great difficulties mastering technical German. And yet, he is from Alsace. According to the Germans, language is the reason why the number of scientific communications sent to France is so low.

The exchanges of all kinds with Nordic countries or with the United States are said to be much more intense.

In France, in the machine-tools sector, researchers are glad of this lack of contacts. They are wrong. The results obtained by the Laboratory and the methods it uses, if they were better known, would enlighten the imagination of our reformists. The WZL has found a niche at the junction between university and industry. Overflowing with the 6,000 students of the Technical Institute, it profits by their abilities and, reciprocally, provides them the benefit of contacts with workshops. Thanks to it, the best brains are not afraid to engage in the study of machine-tools.

#### Four Heads That Agree

In France, CERMO (Center for Studies and Research on Machine-Tools) is comparable to this structure, because of its connections with the industry and with the School for Industrial Arts. But we must recognize that many Machine-Tools Plans will flow under the bridges before they reach the German dimension. The WZL is "monstrous." It has four heads which share the projects between themselves. These are the Chair of Production Engineering, the Chair of Manufacturing Technology (tools, cutting, forming...), the Chair of Machine-Tools (study of structures...) and the Department of Metrology. Why were the metrologists not given the honor of a chair? In practice, a few projects are managed jointly by two or three of the heads. The strict breakdown given above is, therefore, somewhat arbitrary. Nevertheless, it is made necessary by practical considerations. The Laboratory occupies an office building on the university campus and a 3,200 square meter workshop.

#### A Wardrobe for a Robot

In Prof M. Weck's department, the star billing is given to a flexible cell with two handling robots. It is connected to numerous projects, such as form recognition, a prehensile system, a direct numerical control. On one side, two lathes and a stack of rough and finished parts. Between the machines, a robot on rails. It transfers half-finished parts from one station to the other and discharges them. On the other side, a machining station. In the middle, an articulated arm with six degrees of freedom manufactured by Volkswagen.

### A Clamp for Each Use

The robot brings the part to the machining station. When the work is completed, it removes it and takes it to the check-out, under a camera. The camera also helps the robot grab an object. After analyzing the image, the computer informs the arm of the adequate position. The optical treatment is quite long, of the order of 30 seconds. Fortunately, the camera goes on working without waiting for the computer. Each cell component (camera, robots, machines) is provided with its own control. The computer room is involved only with the overall management. Ulrich Dern, a young engineer, is perfecting a software model adapted to this type of direct numerical control. In addition, the Chair of Machine-Tools is experimenting with an automatic clamp-changing system. Before starting on a batch of a different shape, the robot strips and chooses the appropriate clamp in its wardrobe. A study on how parts are grabbed has led to the use of four inductive sensors on each hand. They check the position of the object and order the robot to start all over again if the position is wrong.

Professor Weck's team is also engaged in basic research on machine-tools, such as the dynamic behavior of structures, using a Fourier analyzer. The operator simulates an excitation of oscillations and observes the weak points on the screen. In statics, the thermal variations of bearings is studied. When subjected to an artificial load, their temperature tends to increase. In acoustics, an anechoic chamber receives very large machines. Several German and Belgian gear-box manufacturers have joined to order a study from WZL. We saw the results: side by side, the old and the new gear-box models. The latter is based on measurements made in the anechoic chamber to reduce noise. This type of cooperation with the industry is remarkable. Do you know many manufacturers who could forget their rivalries long enough to carry out joint research? The Chair of Machine-Tools frequently cooperates with Professor Koenig's Chair of Manufacturing Technology. For instance, to measure stresses along the three dimensions of a milling machine. These tests in progress involve the structure of the machine as much as the machining process. Like his colleague, Professor Weck does not neglect grinding. One machine is provided with electronic sensors which monitor the work in progress.

The researchers analyze the quality of the contact with the grinding wheel. They like to say: "No two projects are alike among the hundreds which are carried out at one time or another... But each of them adds to our experience."

### Profitable Super-Abrasives

Secret though it may be, let us now talk about the milling lathe, a horizontal lathe on the carriage of which a cutter with several teeth is replacing the carbide bit tool. In operation, the part and the tool spindle are both rotating. Heyligenstaedt, the German manufacturer who originated the project, asked the Chair of Manufacturing Technology to study the combination of the two motions. Since a shock occurs every time the material is attacked by one of the cutter teeth, the final surface finish leaves something to be desired. If this disadvantage, as well as the problem of programming all the motions, can be overcome, the machine will offer a metal-removal rate and a sophistication of forms out of the ordinary.

## Is Milling on Its Way Out?

According to Prof Wilfried Koenig, head of the Chair of Manufacturing Technology and director of the Fraunhofer Institute for Production Technology, most research is now devoted to grinding. "We want to replace 'high-speed grinding' by 'high-efficiency grinding.' Our super-abrasive grinding tests show that this technique can compete with traditional milling." Here, a cylindrical grinder is producing twist drills. The tool used is a grinding wheel with cubic boron nitride inserts. Professionals might be tempted to scream. In France, this super-abrasive material is judged too expensive and is not used much. If they knew! Mr Koenig predicts no less than a fivefold increase in productivity, taking investments into account. Initially, WZL observed a trend toward smaller batches and series in mechanical engineering. As a result, frequent variations in tool geometry, especially in drill geometry, were becoming necessary. Therefore, a more flexible fabrication method had to be found. Usually, the part is milled, then heat treated, and then ground to the required finish. Each operation requires adjustments and handling. With a single grinding operation on a numerical-control programmed-displacement machine, the flexibility desired can be achieved. For a depth of 4 mm, with a speed of 20 m/s and a feed motion of 2.75 m/mn on the grinding wheel, the machining time is reduced more than tenfold. Thanks to an extremely powerful 60 kW machine which costs hardly has much 2 milling machines. A comparison between cubic boron nitride (CBN) and traditional abrasives also yields spectacular results. According to WZL, with conventional abrasives the metal-removal rate is less than  $1 \text{ mm}^3/\text{m}^3/\text{s}$ . With CBN, it is  $180 \text{ mm}^3/\text{m}^3/\text{s}$ . With a high feeding speed,  $620 \text{ mm}^3/\text{m}^3/\text{s}$  can be achieved. And the researchers guarantee that no changes in the structure of the metal take place. The contact zone remains cold. But WZL had to adapt a special lubrication device which sprays 150 liters per minute under a pressure of... 19 bars.

Another radical change: the size of gears, an important sector of German activity. Contrary to France, where no manufacturers produce this type of machine. WZL proposes to replace the traditional method of metal removal by cold forming. The advantage would be that less noble, i.e. less expensive metals could be used. Also, there would be no loss of material. Some truck gear-box manufacturers are interested in this prospect. Cold-forming with compression by a knurled tool would result in surface hardening of the metal and, therefore, more ordinary metals could be used. In the same perspective, researchers are working on a cold-molding Schuler press.

## A Return to Adaptive Control

In electrical-discharge machining (EDM), Professor Koenig presents an interesting adaptive control experiment. "A luxury 20 years ago, a reasonable project today with the electronic components now available." On a travelling-wire EDM system, the objective is to extend the tool life. This is a recent and highly empirical technique. On the one hand, the German engineers must experiment by trial and error with different types of materials. On the other hand, they use micro-electronic techniques to prevent the wire from breaking, a costly incident both in time and money. Their adaptive control monitors the physical

parameters of the wire. It receives signals produced by force sensors and, whenever the wire threatens to break, it modifies the operating conditions. We shall follow up on this. This device might be on sale at some future machine-tools show.

#### German Manufacturers Do Not Hesitate to Lend Their Best Machines to WZL

##### Analyzing the Shape of Chips

However, similar tests carried out on a lathe will never be published. That system is used exclusively by a carbide bit manufacturer. Based on the life-time displayed by the operator, the experiment consists in defining the best machining parameters for each cutting tool. A microprocessor measures the forces exerted on the bit and analyzes the shape of the chips. Piezo-electric sensors integrated to the machine transmit the signals. The electronic control then carries on a dynamic self-regulation. Still in regulation systems, WZL is studying the orbital motion of electrical-discharge machining systems. This rather recent device is not well known. It uses a simple electrode, the wear of which is corrected by a steady motion of the table. The Laboratory is attempting to optimize this motion so as to avoid, for instance, short-circuits in angles. To do so, it varies the speed and the pulses coming from the generator. The workshop also includes an electrochemical machining system. This process, again, is not much used in France because it is expensive, polluting, and difficult to use. The equipment costs 1 million marks. But it is suitable to the machining of difficult shapes and materials, for instance to drill long thin holes into diamonds.

As we already said, there is plenty of sophisticated equipment at the Laboratory. To the point of saturation. Expansion of the workshop will soon start, to accommodate the power laser now being installed. This laser, intended for the metallurgical analysis of cutting and heat treatment, will supply a power of 3 kW. It is modular, which means that when more room is available, two more identical units will be added to produce a total power of 9 kW at the end of the line.

Next to it is a water-spray cutting machine used for most non-metallic materials. Through a ridiculously small nozzle, the fluid is expelled at 900 m/s under a pressure of 4,000 bars! Several parameters are analyzed, among which temperature, nozzle diameter, distance between the nozzle and the part. The engineers are wondering. There is no theory to explain what happens between the part and the water spray.

##### Toward High-Speed Milling

But in order to improve cutting quality, they have already proved the existence of a dispersion of the spray resulting from the wear of the nozzle. Like the laser, this machine in fact belongs to the Fraunhofer Institute, headquartered in Munich, which is represented here. Twenty of its employees are already working at WZL; they will be 100 next year. The last acquisition of the Institute is a two-spindle milling machine, one of them a high-speed spindle. It can reach 30,000 rpm, with a feed velocity of 6 m/min. Comparable

models exist at MBB (Messerschmidt) and VFW [United Aeronautical Works] (Fokker). After our review, Professor Koenig smiles when we ask his opinion on WZL compared to other technical centers. "Well, what do you think?"

#### Flexible Workshop: No Preconceived Idea

Messerschmidt's flexible workshop in Augsburg is somewhat like WZL. Two or three years ago, Prof W. Eversheim's Chair of Production Engineering prepared an investment planning and a simulation of tool requirements. The plant, where the fuselage for the European Tornado aircraft is machined and assembled, is famous for its high degree of automation. A network of computers coordinates all the flows: the parts being machined are on wire-guided carriages, the pre-adjusted tools on an overhead conveyor.

#### Further Progress in Computer-Aided Design

The optimization of machine-tool use is reflected in other experiments. Today, the team is studying the production of spare part by an automobile manufacturer. The same machines are used to produce widely different series. The major problems encountered have to do with tool management. Why do large companies ask WZL to carry out such studies? "They do not always have adequate simulation means," comments Professor Eversheim. "And above all, they know that, in Aachen, we work with an open mind and without preconceived ideas as to the choice of equipment." The professor is using the experience gained on the flexible cells shown at the Burckhardt & Weber booth at the 1981 Hanover Machine-Tool Show to prepare a project for the American company Cummins, a manufacturer of large Diesel engines.

Computer-aided design is another facet of his activity. His engineers have developed a software to reduce form definition to a minimum. It is no longer necessary to list lines, points and angles. The indication of the shape--"cylinder" for instance--is enough. But problems have arisen, among other things in distinguishing between hollow and solid volumes. American aircraft manufacturers are cooperating with WZL. Since 1978, Detail 2 software has been adopted by some 10 companies. But Professor Eversheim does not get involved in marketing. He prefers working on the extension of his system to manufacturing. His objective is to computerize technological data and machining instructions. Autap NC, a software to assist in programming skewed surfaces, has already been developed.

These various research projects are supported by quite a lot of equipment. The central CDC Cyber 175 computer is shared by several institutes. It has 1,250 kilobytes of memory and 700 megabytes of disk units. Around this unit, there are two 32-bit minicomputers, a few tabletop computers and quite a crowd of microcomputers. The specialists can judge...

This network is used for designing, for programming on numerical control tape, for static or dynamic behavior simulation and, last but not least, for the simulation of flexible cells.

However considerable these tasks may be, the network capacity seems safe from saturation.

## Laser: Measurements to 0.1 Micrometer

Prof T. Pfeifer's Department of Metrology represents above all sophisticated equipment at the service of all departments. Among other things, three laser interferometers, two Fourier analyzers, a Zeiss three-dimensional measuring machine. In the climatized room, researchers measure a drill to 1 micrometer. In France, you would call that taking a sledge hammer to crack a nut. But why should the fabulously wealthy Laboratory do without?

To say the truth, some of this equipment is on loan from manufacturers for research contracts. The measuring machines are used to analyze procedural errors, the data required for the geometrical definition of a part, and the precision. Following the trend of the day, the department is interested in electronic sensing devices of the Renishaw type. It studies their use on machine-tools. In the workshop, on a Maho machining station, such an instrument can replace a tool. It provides the station with the capabilities of a measuring machine. A trainee detects the positioning or geometry errors induced by the machine or the initial setting of the tools.

He wants to achieve a self-compensating system which would improve machining precision without the assistance of a human controller. The orientation of this research demonstrates the interest of German manufacturers for the integrated control of machine-tools. Without it, automation is not possible.

### Up to 60 Meters

Laser is becoming increasingly important. This is due to the frequency of linear and angular measurements in mechanical engineering. Now, the laser interferometer is the tool best suited to this type of checking. It guarantees a resolution of less than 0.1 micrometer and can measure up to 60 m. At WZL, it is used on machines to compare real and displayed dimensions. Also, it is used to check straightness, planeness and orthogonality.

In quality control, the researchers achieve a precision equal to that of top-of-the-line electronic comparators. They use solid-state image converters and, more generally, contactless optical sensors associated to a microprocessor. But these laboratory jewels are not working alone. They are dependent on adequate data-processing for which the Metrology Department collects data banks. Today, there is a trend toward decentralized networks, one of the first models of which in the FRG was built with the assistance of WZL. The instructions are distributed by the master computer to the computers of each piece of equipment, and carried out independently. For the final compilation, the measurement analyses go back to the central unit. A very high level programming language is used with such systems. It is Pearl, a software which is adapted to the working methods of the controllers and in keeping with the capabilities of the minicomputers. Let us mention that a three-dimensional measuring machine is just as complex to handle as a numerical-control machine-tool. This is what makes computer assistance interesting. The Laboratory has also developed a programmation-assistance software, NCMES [expansion unknown]. This software is independent of the type of computer used with the measuring machine. In short, the problems of metrology are similar to those of the other departments, whether with respect to the data processing network, to machining precision, or to the structural quality of the machine. There is no compartmentalization.

## INDUSTRIAL TECHNOLOGY

### ASEA TURNS EFFORTS TO TURNKEY MANUFACTURING CELLS

Paris INDUSTRIES & TECHNIQUES in French 1 Jun 82 pp 25-28

[Article by Andre Larane: "Robots: A Trend Toward 'Turnkey' Systems"]

[Text] Rather than going for an articulated arm mechanism, ASEA directs its efforts toward "turnkey" cells.

It is possible to plan manufacturing 800 robots in 1982, twice as many as in 1981, and still have no connections with the machine-tools sector. This is the case of ASEA [Swedish General Electric Corporation]. The Swedish giant is the 10th electrical engineering company in the world; the 4th after General Electric, Siemens, Hitachi, if taken together with other Swedish companies in the same sector: Electrolux (white products) and LM Ericsson (telephone). ASEA means both the high-voltage converters of the Itaipu (Brazil) dam and nuclear power in Sweden. It is also the only company to have developed a pressurized water reactor independently from Westinghouse. And for the past 10 years, it has been involved in robotics.

The latter has a prehistory since ASEA flatters itself to have been the first non-American user of a robot (Unimation). That division is in favor with the present management. It is much more dynamic than the electrical products division, and can look forward to a sustained expansion. In France, for instance, ASEA maintains an office employing 14 technicians and a testing center at Persan in the Oise department, although only some 50 robots have been installed. Obviously, ASEA expect a rise in the demand... which it had overestimated initially. Contrary to manufacturers in other western countries, the French seem to respond slowly to the shock of robotization. Should we attribute this delay to psychological fears or merely to a drop in investments?

It is all the easier for ASEA to provide massive support to its robotics division as the latter does not amount to much: hardly 300 people at headquarters out of a total of 56,000. Like most plants of the group, it is located in Västerås. This medium-size town, some 100 km west of Stockholm, is therefore considered to be the Mecca of Scandinavian technicians. The robotics division has been independent for a few months; before that, it was an appendage of the electronics division which, among other things, manufactures numerical control cabinets and, of course, continues to assemble the boards and cabinets for the robots. In a 5,600 square meter workshop, some 100 workers are busy assembling manipulator arms, carrying out tests and shipping products. Another 100 people are working in the engineering and design department. They are modifying the line of products and, above all, solve the trickiest layout problems. The last third of the personnel is engaged in sales and relations with customers.

Surprisingly, the products themselves have not changed much. An adaptation of electronic characteristics to the recent progress in the field of components is impending. As for the mechanical characteristics, Pol Peny, in charge of the French market at Vasteras, insists that there is no reason to change them except for details. All robots include a rotating pivot to which a forearm that moves radially and an arm that moves vertically are attached. The wrist can move both in rotation and vertically. This amounts to a total of five degrees of freedom. A sixth degree is optional: on the smaller model, it is provided by the addition of a rail translation with a capacity of 6 kg under load; on the larger model, by the addition of an appendage to the wrist, with a capacity of 60 kg. On the larger robot, the six axes are used mainly for spot welding, on the model which the manufacturer calls IrB-60S.

#### International Components but Home-Made Tools

Because of its traditions, ASEA has oriented itself from the start toward all-electric robots. Each of the five or six axes is controlled by a motor. The movements are transmitted by small connecting rods. Other manufacturers use flexible chains which may be less reliable. Lars Erik Ringstrom, the technical manager, justifies his preference a posteriori by comparing it with a hydraulic system. "No cumbersome refrigeration unit, less power consumption, and an easy--even pleasant--maintenance." In any layout study, the importance of the first criterion is unquestioned. To serve several machines and a parts loading/unloading station, the robot is limited by its reach--about 2 meters--and its operating range--about 330°. The useful space, therefore, cannot be further reduced by accessories. From this point of view, the possibility of moving the control cabinet of the Swedish robot up to 15 meters away is appreciable. As a counterpart, it is obvious that an all-electrical system is less suited than a hydraulic system to the handling of heavy parts. Our industry is concerned. The motors for the axes are supplied by the French company CEM [Electromechanical Equipment Company], whereas the resolvers come from the United States and the gear boxes, alas, from Japan. All components, whether purchased or subcontracted to other divisions of the group, are sent to the workshop to be assembled in series.

In order to place itself among the leading robot manufacturers, the Swedish company has decided to develop a limited line of standard products. But it is concerned with maximizing its application range. After buying a brand of simple manipulators, ASEA considered a model with greater reach and lifting capacity. As a result, production increased steadily. But the assembly line remains very Swedish in its appearance. No frantic activity, no stress are noticeable. Some believe that this reflects a refusal to get involved with the work. That is not so sure... Assembly takes place in batches of a few units. In one corner of the workshop, the pivots are first assembled. Further, the arms and the control mechanism. Each electronic or mechanical subassembly is the object of a partial test. The cabinets and the robots are subjected to a final 72-hour testing program. No spectacular automation in all that. But, next door, where the printed circuits for the arms cabinets as well as for other equipment are manufactured, the electronics division is operating a home-made robot to drill the plates. Its operation as well as the semi-automatic assembly of the components are coordinated by a central computer. The drilling

cell consists of two programmed three-headed machines. The number of plates they machine each time varies with the requirements. Following instructions from the computer, the robot takes plates out of the magazine and forms a complete batch on an available shelf. The clamp is provided with a special pin to separate the metal sheets. The same clamp also grabs new drill bits and loads the tools on the machines whenever a drilling machine has received the parts it needs. The previous batch is countersunk and then discharged by the robot. In the circuits assembly workshop, the indications of the type of component to be assembled and of their location is computerized. All samples are supplied on a partitioned tray. The lid being partially open, the hand can dip only in a given section. Prior to each operation, the computer causes the tray to rotate thus offering the necessary component to the worker. Above the working table, a movable light, which is also computer-controlled, projects a light spot on the plate. Its successive positions indicate the location of the components.

In this manufacturing process, the robot offers the advantage of working night and day. It constitutes buffer inventories. Should an incident occur when no supervisor is at hand, it is programmed to skip the current operation and, if possible, go on to the following. But there are applications more representative of the capabilities of this type of equipment.

Lars Erik Ringstrom wishes to supply specialized packages, in other words turnkey cells. He is already doing so for arc-welding under an agreement with the Swedish firm ESAB [expansion unknown]. ASEA supplies a small capacity robot and the adequate software. ESAB adds the torch, the power supply and the control console.

#### Toward Improved Reach and Lifting Capacity

Arc-welding remains the principal market of ASEA, which has supplied 600 of the more than 1,500 robots now in operation.

The remainder breaks down between spot welding, machine-tools feeding systems, handling equipment and various processes such as the gluing and cutting of composite materials. Will turnkey cells soon be available to finish castings? In a room at Västerås, a cell is being tested on a robot next to which stands a tool rack. As required, the robot arm grabs a plasma cutting torch or a fettling wheel. It then processes the part placed in front of it. All the while, a worker is discharging the previous part and loading the next one on another tray. As can be seen, standard accessories are adequate to finish a large variety of series.

Things are not as simple when it comes to machine-tools feed mechanisms. Each cell is different, either because of the shape of the parts, or because of the type and age of the machines. At Västerås, in a motor production unit, ASEA assembled a robotized system consisting of a Georg Fischer lathe, two old numerical-control Cincinnati drilling machines equipped with capstans, and one control machine. On the feed belt, parts-carrying pallets are provided with screws to adapt them to several dimensions. They bring cylindrical flanges. With the two prehensile clamps of its hand, the robot removes the finished part from the lathe and deposits the rough part.

## Articulated Arms Fulfill a Real Need in Welding, Machining and Foundry

To tell the truth, contrary to turnkey cells, this application offers the advantage of giving a new life to old machines at the cost of a few changes. In the aluminum casting workshop of the same plant, the whole stator manufacturing process has been automated with two robots. The stator components are cut from rough sheet-metal and stacked. A robot takes the stack to a press where a dummy axis is inserted in its center. The second arm transfers the whole thing to an aluminum injection press. The whole carcass of the stator is then molded around the stack. After cooling and removal of the dummy axis, the first robot palletizes the finished part.

The order of the operations--molding around the stator rather than inserting the plates into a premolded carcass--was adopted to make robotization possible.

At the Västeras engineering and design department, Lars Erik Ringstrom is studying devices which will make the articulated arm into a truly intelligent machine. For instance, during grinding and deburring, sensing devices placed on the clamp will detect excessive thicknesses. They will transmit this information to the cabinets where the machining parameters will be modified accordingly. In addition to this adaptive control, ASEA is also interested in the optical recognition of the parts being assembled. The difficulty there is no longer to distinguish between black and white, but to interpret shades of grey.

Although extremely fruitful, this type of research is of no immediate interest to average manufacturers, but they should not forget that the articulated arms which exist today answer a real need in welding, machining and foundry. They are not mere toys to be shown on television or by automobile manufacturers looking for publicity.

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CSO: 3102/372

INDUSTRIAL TECHNOLOGY

BRIEFS

IMAGE ANALYSIS IN MANUFACTURING--The Micro-Videomat device from Carl Zeiss, Oberkochen, can be used to measure geometric sizes, to position components, to recognize structural characteristics. The image analysis system--which could be seen in Room 4--is suitable not only for quality assurance but also for control in the manufacturing process. Components can be matched according to selected criteria, and with fairly large manufacturing tolerances rejects can be minimized. A TV camera serves as an optical sensor for the Videomat. Among the stock of standard functions is, for example, "Fill-in" whereby holes in parts are filled in by software operations, so that they are measured along with surfaces, or in counting, parts are simply counted as concave parts. The function "Threshold" serves to form the digital image. The analog image can be made binary by two selectable picture halftone thresholds; interesting image details can be singled out. [Text] [Duesseldorf VDI NACHRICHTEN in German 14 May 82 p 6] 9485

CSO: 3102/343

## TRANSPORTATION

### DORNIER BUILDS COMPOSITE-MATERIAL HORIZONTAL STABILIZERS

Duesseldorf VDI NACHRICHTEN in German 23 Apr 82 p 24

[Article by RCS: "Alpha Jet in Carbon-Fiber Construction--Composite-Material Horizontal Stabilizer Unit Matured to Undergo Flight Tests"]

[Text] A new technological era is about to commence in aircraft cell construction with the use of new materials, particularly carbon-fiber reinforced plastics (CFK). For more than 10 years Dornier has been working in the development of ultralight components which will be used for the German-French strike and training aircraft, the Alpha jet, or will be tested on it for application in future combat aircraft.

Following the CFK brake flaps, which are already manufactured in series, and the CFK side rudder currently undergoing long-term testing, an Alpha jet horizontal stabilizer unit of composite fiber construction will undergo flight testing within a few months. This component was also developed by Dornier, Friedrichshafen, as part of the aircraft component and testing programs (KEL) sponsored by the Federal minister of defense.

The required trials for flight testing of this CFK primary component, which is the largest one so far built by Dornier, were successfully completed by late 1981.

In comparison to the light-metal version of the Alpha jet's horizontal stabilizer unit which already had an optimum mass, additional savings of 18 percent in mass were achieved by the use of CFK.

In cooperation with the German Institution for Research and Testing of Aircraft and Spacecraft (DFVLR) in Stuttgart, new production techniques have been developed (monolithic construction) utilizing the design potential of the CFK material. The new production techniques resulted in a reduction of the number of individual components from 215 (aluminum version) to 80 in composite fiber construction and from 5,000 to 1,200 connecting elements. Thus, assembly costs were drastically reduced.

Upon completion of the qualification tests which were conducted at IABG's (Industrie- und Anlagenbetriebsgesellschaft), Ottobrunn, the airworthiness of the CFK horizontal stabilizer unit has been demonstrated. Statistical and

dynamic proof--taking varying operating temperatures and component humidity contents into account--was demonstrated on a single horizontal stabilizer unit.

Flight testing of the horizontal stabilizer unit on the Alpha jet 03 prototype is scheduled for this year. Prolonged testing at actual operating conditions by the German Air Force is to be conducted with a larger number of elevator units.

Experience gained from long-term testing is to strengthen the confidence in the new construction, on the one hand, and provide findings for future component developments, on the other hand.

These tests and industrial flight test series provide the necessary basis of confidence in the scheduled large-scale application in series of composite-fiber structures for future aircraft.

At Dornier, the next step on the way to a "CFK aircraft" is the construction of a wing made of carbon-fiber reinforced plastic for the Alpha jet.

9544

CSO: 3102/318

## TRANSPORTATION

### RENAULT VEHICULES INDUSTRIELS REAL-TIME FLEXIBLE WORKSHOP

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[Text] RVI [Renault Industrial Vehicles] is offering a new gearbox, the B 9. This synchronized system is designed to be used with top of the line engines of 220 to 400 ch [hp], with intake couples of 100 to 170 m.daH. At present, this system is being used on the GRH 235 6 x 4 and GBH 280 6 x 4 construction vehicles. It will gradually be extended to the entire top of the line.

#### The B 9 Gear Box System

The B 9 is a synchronized mechanical gear box with eight forward speeds, plus one extra-slow speed, and one reverse. It will be developed so it can be used for special services, required by changes in transport and in vehicle types.

Before being manufactured, RVI spent 7 years on research and testing of the system. It has traveled the equivalent of 15 million kilometers. Transporters have used 75 vehicles equipped with a B 9. It is designed to last for 600,000 kilometers.

The objectives in developing the B 9 system were:

- a. Speeds should be synchronized for easier handling;
- b. There should be an extra-slow speed for maneuvering and for exceptional efforts;
- c. It should be compact so it can be mounted on vehicles with a very short wheel base;
- d. It should be able to be fitted with an electromagnetic idle system;

- e. It should be able to be equipped with different types of power connections.

The kinematic system of the gear box consists of three related mechanical units:

- a. There is a main mechanical box with four synchronized speeds, using spiral-cut pinions, primary and secondary coaxial axles and an intermediate axle.
- b. There is a third axle in the main box; this is used to provide an extra slow speed and reverse; this was designed to take up less lengthwise space.
- c. There is an auxiliary box with two speed ranges, obtained by an epicycloidal reverse gear, which multiplies the four main speeds by two. This forms what is usually called a staged box.

The three crank cases are stacked axially.

- a. The main crank case contains the gear shift, the main box with four synchronized speeds, the slow speed, the reverse gear, the direct or indirect manual shift control, the fork guide and locking system, the assembly crank case for the power system, and the oil pump.
- b. The intermediate crank case contains the epicycloidal gear which doubles the range of speeds.
- c. The back lid contains the double synchro to control the epicycloidal gear, with its pneumatic control jack and tachymetric connections. An alternate version can have the Telma Focal from 170 to 250 installed.

The materials used are:

- a. For the main and intermediate crank cases, gray cast iron [cast iron no 2].
- b. For the third crank case, an aluminum alloy or cast iron, depending on whether it is only a lid or is a support for the Focal electromagnetic system.
- c. The axles and pinions are made of forged chrome steel.

The synchros with positively active floating rings oppose any maneuver when synchronism is not established. The gear can only be engaged when the pinions are turning at the same speed. They are made of stamped metal with a surface treatment.

### The Flexible Workshop

As the B 9 system is quite unlike the systems made until now in the specialized plant at Boutheon, RVI had to set up a new production unit. It selected the real-time flexible workshop system.

The flexible workshop is an entirely automatic manufacturing system which can combine productivity and flexibility for parts being made in small and medium quantities.

For the construction of this workshop, RVI had three essential requirements.

- a. Flexibility in volume. The volumes to be manufactured may change in quantity and in time. So the initial investment begun in 1979 called for a capacity of 70 collections of crank cases for gear boxes per day. A supplemental investment will be made in 1983, bringing the capacity to 100 boxes.
- b. Flexibility in products. The design of the product may change because its development continues until it is put on the market, because it must be adapted to meet the needs of the market, requiring changes in options and variants, and because the original product can have other types added to it.

As an example, between the time the workshop was ordered and its opening, several modifications in products were requested by the research staff, and these were easily made.

In addition, two variants in the gear box are planned for the end of 1983. These will require supplemental machining of the main crank case and the making of a new part. These supplemental machinings will be introduced without any problems.

- c. Flexibility in stock management. RVI wanted the adjustment time required for switching from one reference to another to be as short as possible in order to decrease the length of series and stockpiles.

Using the flexible workshop has completely eliminated adjustments needed for switching from one reference to another for the four parts now being made there. Now there can be a direct flow of work between manufacturing and assembly, which reduces the number of parts kept immobilized. The flexible workshop also provides a flexible response when machines break down. There are several types of identical machines in the shop. In addition, machining centers can handle all types of work done by other machines.

In terms of productivity, the selection of the machines and the optimization of their use mean that the investment has a cost comparable to that of a more conventional system, and operating costs are slightly less.

The Boutheon flexible workshop can be considered a worldwide first since this is the first such system in operation which is controlled in real time, combining a daily production schedule with an instantaneous reaction to whatever happens.

It is also a first in Europe in terms of manufacturing, since it features complete automation with the use of robotic transport carts. This automation is increased by the automatic exchange of the battery racks.

We should also mention the development of the boring-edging machine which has horizontal spindles that can produce all types of cylindrical or spherical shapes.

One added advantage of this shop is that it takes only 4 hours to change production, instead of the 80 hours usually needed. This decreases the stocks on hand.

The Boutheon flexible workshop has a floor area of 3,000 m<sup>2</sup>. It has seven digitally-controlled machine tools with automatic tool changers. The entire facility is serviced by eight robot carts.

Three Renault subsidiaries took part in developing this facility: the Castres Mechanical Company, which served as prime contractor; the SEIV Automation, which provided the eight carts; and the Programmable Robots Company SMC, which provided the 25 programmable robots used in the shop. Investments came to 45 million francs.

There are now 15 people employed in the workshop, who start the operations and increase the rate of work. Most of them were hired from traditional occupational fields, and were trained in the digital control of programmable robots, industrial data processing, etc. They were given a total of 10,000 hours of training.

### The Boutheon Plant

The assembly of the B 9 gear box is done in conventional shops of the Boutheon plant. This plant was set up by Berliet in 1970 to produce and assemble gear boxes, and now has an area of 30,000 m<sup>2</sup> under roof. This plant produces gear boxes which can transmit a couple of 70 to 170 m.daN; these are used in vehicles of over 15 tons, with engine powers of 180 to 400 hp. The current production is about 100 boxes per day, with three lines of gear boxes in production. In all, 570 people are employed here, and 100 jobs have been created since the beginning of 1980. The number of jobs should reach 700 in 1985, with a total production of 150 gear boxes per day at that time.

The industrial production of the new B 9 box and the expansion in the capacity at Boutheon required total investments of 300 million francs.

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